A Prototype Next-Generation Mobile Phone Fuel Cell With High Output Power

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Nippon Telegraph and Telephone Corporation have developed a prototype micro polymer-electrolyte fuel cell (PEFC)1 that uses hydrogen gas as a fuel and is small enough to directly fit in a mobile phone. Under tests using a production-model mobile phone, this prototype PEFC successfully powered start-up and signal reception/transmission (i.e., video phone, voice calls, and "i-mode" internet services). In conjunction with this development, we also developed a device for automatically topping up the micro PEFC with hydrogen.

At present, the direct-methanol fuel cell (DMFC)-which uses methanol as the hydrogen fuel supply-is the mainstream development concerning batteries for mobile-phone use. However, a DMFC suffers two key problems: firstly, CO2 is produced during power generation; secondly, since the power density per unit area of the power-generation part is insufficient, battery miniaturization is difficult.

In light of this problem, utilizing hydrogen gas as a fuel, the PEFC we have developed at NTT attains a high output power compatible with that of a lithium-ion battery without producing CO2 during power generation. On top of that, as a result of unifying the power-generation unit and the hydrogen-storage alloy tank and simplifying electrical circuitry, our PEFC has a compact size (external dimensions: 42*80*13 mm; weight: 104 g), which makes it suitable for directly fitting into a mobile phone, and enables a talk time of nine hours. Furthermore, by changing the surface area of the PEFC's power-generation part, it is possible to apply the PEFC to a wide variety of mobile electronic devices like video cameras, digital cameras, PDAs, and notebook PCs.

Development background

In recent years, as high performance and multi-functionality of mobile electronic devices (such as mobile phones and notebook PCs) has advanced, the problem of insufficient capacity of batteries as the power source of these devices has come to the forefront.

Under these circumstances, investigations on energy sources to replace the lithium-ion battery-which is nearing its limit on further improvements in energy density-are continuing. At the same time, as a breakthrough technology exerting a low environmental load, fuel cells are continuing to create great expectations and spur on their development by many manufacturers.

At present, the direct-methanol fuel cell (DMFC)-which uses methanol as the hydrogen fuel supply-has become mainstream. However, three drawbacks regarding the DMFC have been pinpointed: it produces CO2 during power generation; its power-generation part is difficult to miniaturize, because doing so causes insufficient power density; and its applicability to electrical devices is limited. As a result of these drawbacks,

especially in today's age in which each person carries a mobile phone, it is considered difficult to popularize a compact, all-in-one type of DMFC.

At NTT, as part of our creation of fundament technologies for supporting a “Resonant” communication environment, we are making great efforts to establish environmental energy technologies aimed at realizing a sustainable society, and we are driving forward with research and development on powerful, high-efficiency, clean fuel-cell technologies that will contribute to reductions in CO2 emissions.

Characteristics of the micro PEFC

In a micro PEFC, with hydrogen gas as a fuel, water vapor only is produced as emission. This means that even under a high-power-density environment, a PEFC is a benign and extremely clean power source. It is thus regarded as a next-generation power source that is compact enough for directly mounting in a mobile phone. The main characteristics of our PEFC are summarized as follows.

(1) High power density
Compared to a DMFC (i.e., methanol-fuelled), our PEFC produces a higher output, since it is hydrogen-gas fuelled, even though the power-generation area is smaller.
(2) Compactness
Its high energy density enables a compact size.
(3) Simple construction
Owing to booster technology, the conventionally required "stacking" of cells is unnecessary. And by unifying the hydrogen-storage alloy tank and electricity-generation part, the number of parts and battery size have been reduced.
(4) Long-term power generation
By utilizing a high-capacity bcc2-type alloy system for hydrogen storage, our PEFC attains long-term power generation.

In addition to the above, even in the case of mobile electronic devices such as notebook PCs-which have relatively high power consumption-the micro PEFC can be easily adapted by increasing the area of its electricity-generation part.

Future developments

As regards all-out practical application of fuel cells, several challenges-such as setting up hydrogen-fuel supply systems as part of a social infrastructure-remain to be overcome. However, even given the forecasted increases in power consumption of future devices due to their higher performance and more functions, micro PEFCs are expected to meet the power demand and target early commercial applications.

At NTT, from now onwards, with our goal of realizing the next generation of fuel cells, we will continue to push forward research and development in areas such as further validation of safety and investigation into optimum utilization conditions from a general user's viewpoint.

Explanation of technical terms

***Note 1: PEFC (polymer-electrolyte fuel cell)**
A solid, polymer-type fuel cell. Thanks to its high output power density even under room-temperature operation, the PEFC has been actively developed over recent years. At present, as the mainstream fuel cell for application in mobile devices, the direct-methanol fuel cell (DMFC) is one type of PEFC being rapidly developed. Compared to a PEFC that is fuelled by hydrogen gas itself, however, a DMFC suffers from a lower power density.

***Note 2: bcc type**
Body-centered-cubic (bcc) type. One kind of alloy crystal structure being studied as a storage and supply medium for hydrogen. In recent years especially, bcc materials have drawn attention as the storage medium used in the fuel tank of fuel-cell-powered motor vehicles.